Human Supervision of Multi-Robot Systems

Donald Bourque (RBE), Thomas DeSilva (CS), Nicholas Otero (RBE)
Advisors: Professor Taskin Padir (RBE/ECE), Professor Sonia Chernova (RBE/CS)

Project Overview

This project involved the design of a framework for human supervision of multi-robot systems. These systems could be used for various applications in which the robots cannot or should not perform some tasks on their own.

An implementation of the framework was tested in a scenario representative of the identified areas of application (e.g. search and rescue, construction, exploration).

Robots

A heterogeneous team of robots was assembled to test the framework. The robots ran the Robot Operating System (ROS) and used Mecanum, differential, and skid steering. To use them for this project, they needed:

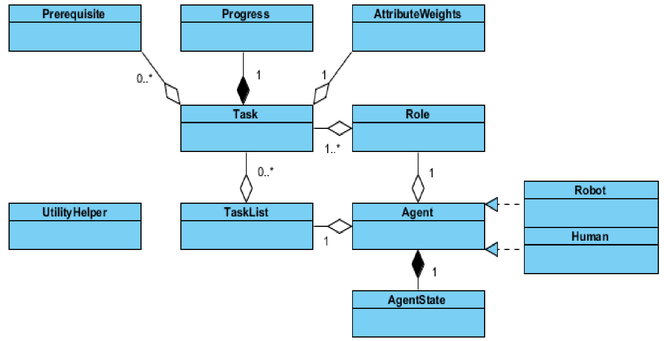
- To be mechanically and electrically repaired
- Programming implementing the framework
- Localization methods
- Two-dimensional path planning and execution

From left to right: Hermes, Turtlebot, and Husky.

Acknowledgments

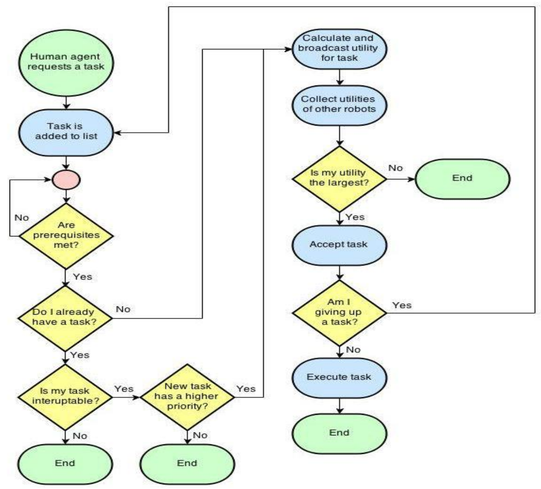
We would like to acknowledge Professors Padir and Chernova for advising our MQP as well as Joseph St. Germain and Clearpath Robotics for providing us with equipment and advice.

Framework Design



Tasks could be autonomously allocated to Robots using a distributed bidding algorithm. Tasks are auctioned when their Prerequisites are fulfilled, and are claimed by the Robot with the highest bid. The UtilityHelper used data stored in AgentStates and AttributeWeights to calculate each Robot's bid.

Roles were given to Robots to disallow certain Tasks from being autonomously allocated. This allowed the supervisor to control which Tasks were assigned to Robots without manually assigning them.



Graphical User Interface

The Graphical User Interface affords situational awareness and the ability to request tasks to the supervisor. It was programmed with the Java Swing library and ROSJava, and used the Model-View-Controller design pattern. The GUI was built with modular components to increase extensibility.

Testing Results

- The implementation of the framework was able to handle the inclusion of multiple robots. Neglect of robots was minimized using features of the user interface.
- Robots were capable of performing tasks involving following Artificial Reality tags, point-to-point navigation, and searching areas.
- Autonomous task allocation gave the most capable robot(s) tasks based on their states and capabilities.
- The supervisor was able to acquire situational awareness of the operating environment and assert high and low level control over the robots .